Electrostatics

Physical Quantity — units

Physical Quantity	units
Electric (q, Q)	Coulomb (C)
Electric (I)	Ampere
Resistance (R)	Ohm (Ω)
Capacitance (C)	Farad (F)
Inductance (L)	Henry
Magnetic Induction (B)	Tesla or Weber
Frequency	Hertz (Hz)
Force (F)	Newton (N)
Power (P)	Watt (W)
Potential	Volt

Electrostatics —

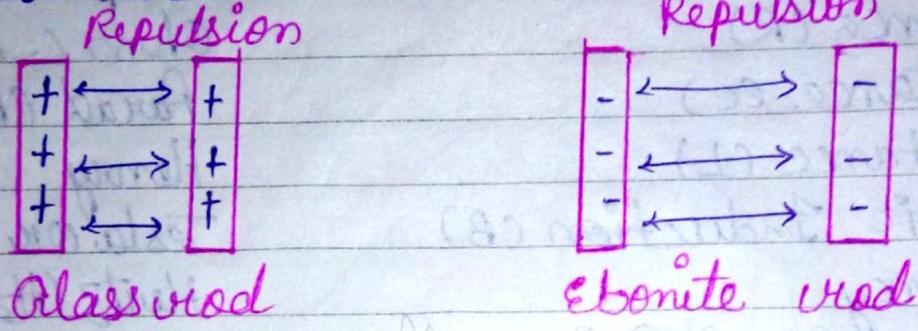
- Electrostatics is a branch of physics in which we study electric charges at rest. The charges at rest are produced due to friction between two insulating bodies which are rubbed against each other.
- Which gives electrons are basically +ve.
- Which take electrons are basically -ve.

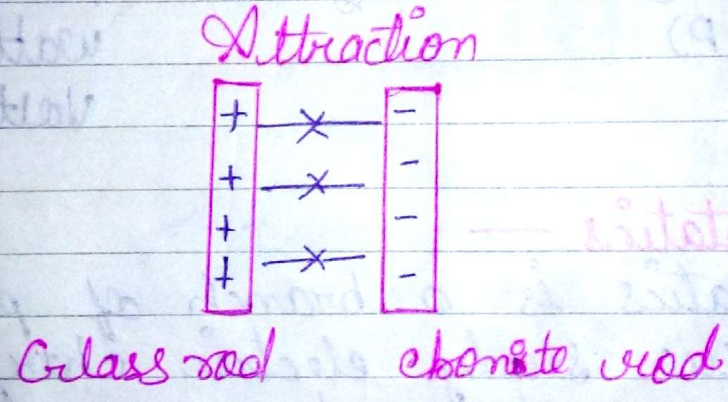
Electric charge —

- When a glass rod rubbed with silk is bringed near to another glass rod which is already rubbed with silk then these two rods are repel each other similarly.

Two ebonite rods rubbed with fur and

bring them near to each other then we will observe that they will repel each other.
But a glass rod rubbed with silk and a ~~glass~~ ebonite rod rubbed with fur get attract each other.





- The object which transfer a quantity during the friction is called the electric charge.
- Same charges repel each other and diff. charges attract each other.

Conductors, Insulators & Semi-Conductors—

(1) Conductors ⟶

- The materials in which electrons are loosely bound and are capable to move from one place to another are called conductors.

- Flow of electrons in a conductor causes flow of charges and the flow of charge is termed as electric current.
- Ex- Silver, gold, aluminium, iron etc.

(2) Insulators —

- The materials in which electrons are tightly bound that they are not capable to move freely in such materials current and heat cannot flows. These materials are called insulator.
- Ex- wood, platic, rubber etc.

(3) Semi-Conductors —

- There are some substances which are neither good conductors of electricity nor good insulators. These substances are called semi-conductors.
- Ex- Germanium, Silicon etc.
- In Semiconductors there are small free electrons & by increasing temperature electrons can be made free from atoms so conductivity increases by increasing temperature.

Dielectric Constants —

- Some insulators are called dielectric. It can't conduct electricity but when an external electric field is applied it induced charge appear on the outer surface of dielectric.
- Ex- Mica Sheet.

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✱ Coulomb's Law —

q_1 ———————— q_2

$\longleftarrow r \longrightarrow$

Acc. to this law the force of interaction betw. any two charges is directly proportional to the product of the magnitude of charges and inversly proportional to the square of the distance between them.

$$F \propto q_1 q_2 \text{ —— (A)}$$

$$F \propto \frac{1}{r^2} \text{ —— (B)}$$

from eq^n (A) & (B)

$$F \propto \frac{q_1 q_2}{r^2}$$

then,

$$\boxed{F = K \frac{q_1 q_2}{r^2}} \text{ (C)}$$

→ electrostatic force constant

→ Coulomb's law for free space

Here K is $\frac{1}{4\pi\epsilon_0}$

where ϵ_0 is permitivity in free space. or dielectric constant

$$K = 9 \times 10^9$$

unit of K is $\frac{Nm^2}{C^2}$.

$\epsilon_0 = 8.85 \times 10^{-12}$

unit → C^2/Nm^2

Coloumb's law for medium ←

$$\boxed{F_m = \frac{1}{4\pi\epsilon_m} \frac{q_1 q_2}{r^2}} \text{ —— (D)}$$

→ Permitivity in medium

al

from eq^n (C) & (D)

$$\frac{F}{F_m} = \frac{\frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}}{\frac{1}{4\pi\epsilon_m}\frac{q_1 q_2}{r^2}}$$

$$\frac{F}{F_m} = \frac{\epsilon_m}{\epsilon_0} = \epsilon_r \rightarrow \text{Relative permitivity}$$

Ex (1) → Calculate force between two charges of 1C. each seperated by 1m in vacuum.

Sol^n → formula → $F = \frac{K q_1 q_2}{r^2}$

Given → $q_1 = q_2 = 1C$

$r = 1m$

$$F = \frac{9 \times 10^9 \times 1 \times 1}{(1)^2}$$

$$F = 9 \times 10^9 N$$

Ex (2) → Two equal charges are placed at a distance 'r'm exerting force 'F'N on each other what will be the new force F_1 when—

(1) The distance between charges is double
(2) The magnitude of both charges are halved
(3) The magnitude of each charge is doubled but distance betw. charge is halved.

Sole^n → Let, $q_1 = q_2 = q$

$$F = \frac{K q_1 q_2}{r^2}$$

$$F = \frac{K q^2}{r^2} \quad \text{—(A)}$$

(i) Distance betw. charges → $2r$

$$F_1 = \frac{Kq^2}{(2r)^2}$$

$$F_1 = \frac{Kq^2}{4r^2}$$

from eq^n (A)

$$F_1 = \frac{F}{4} N$$

(ii) Magnitude of both charges,

$$q_1 = q_2 = \frac{q}{2}$$

$$F_1 = \frac{K\left(\frac{q}{2}\right)\left(\frac{q}{2}\right)}{r^2}$$

$$F_1 = \frac{Kq^2}{4r^2}$$

$$F_1 = \frac{F}{4} N \text{ — from eq}^n\text{(A)}$$

(iii) Magnitude of charges, $q_1 = q_2 = 2q$

distance → $\frac{r}{2}$

Then, $$F_1 = \frac{K(2q)(2q)}{\left(\frac{r}{2}\right)^2}$$

$$F_1 = \frac{K4q^2}{\frac{r^2}{4}}$$

$$F_1 = 16\frac{Kq^2}{r^2}$$

$$F_2 = 16 F N$$

from eq^n (A)

✡ Conservation & quantization of charges—

(1) Quantization of charge—

- charge exists only in discrete manner or in the packet form. This is called Quantisation of charge.

$$q = ne \rightarrow 1.6\times10^{-19}\,c$$
$$\rightarrow n = 0, \pm1, \pm2, \ldots \infty$$

$q = 0$

$\rightarrow$ $q = \pm 1e = \pm 1\times1.6\times10^{-19}c = \pm 1.6\times10^{-19}$

$\rightarrow$ $q = \pm 2e = \pm 2\times1.6\times10^{-19}c$

$\rightarrow$ $q = \pm 3e = \pm 3\times1.6\times10^{-19}c \ldots \infty$

The value of charge lying between these values are not possible

(2) Conservation of charge—

- The charge can niether be created nor be destroyed. Charges always develop in equal and opposite pairs.
- So, the total charge remain conserved.

✡ Electric field (E) $\rightarrow$

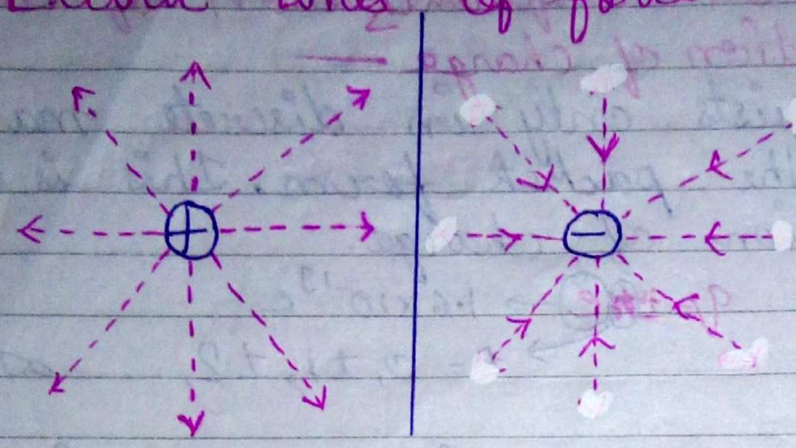
- Electric field of a charge is the space around the charge in which any other charge experiences the electrostatic force of attraction or repulsion.

$$E = \frac{F}{q}$$

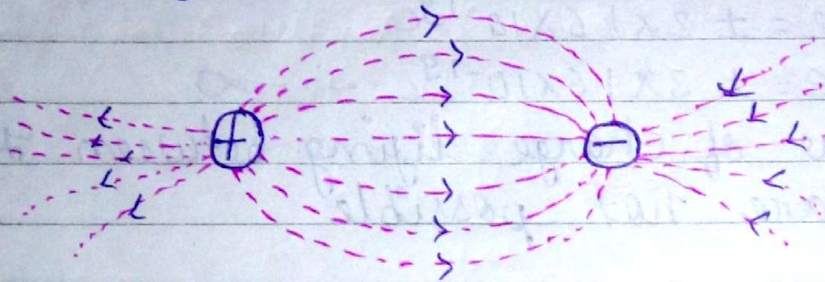
Unit $\rightarrow \frac{N}{C}$ or NC^{-1}

$$\rightarrow E = \frac{F}{q_1} \rightarrow E = \frac{Kq_1q_2}{r^2 q_1} \rightarrow \boxed{E = \frac{Kq_2}{r^2}}$$

Electric lines of force —



(a) (b)



(c)

In dig (a) → Some lines of force due to single +ve charge these are direct ed towards outwards. These lines are extended to ∞

In dig (b) → Some lines of force due to single −ve charge these are direct ed towards inwards.

In dig (c) → If +ve charge and −ve are placed near then electric lines of force are directed from +ve charge to −ve charge.

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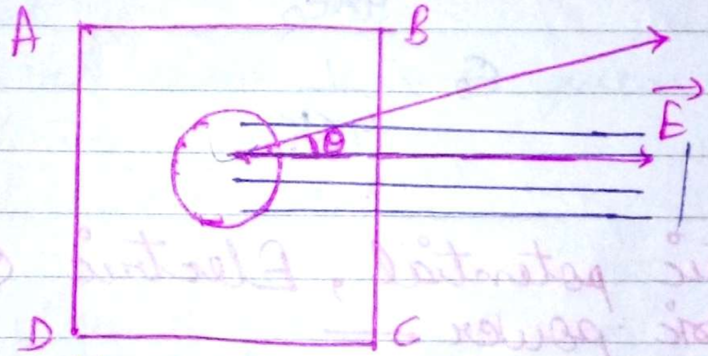
Properties of Electric lines of force

(1) These are imaginary curves.
(2) Tangent to the line of force at any point gives the direction of electric field at that point.
(3) No two lines of force can intersect each other.
(4) These lines start from a +ve charge and end at -ve charge.

Electric flux (ϕ) —



- Electric flux over an area in an electric field is the total no. of electric line of force passing in area.
- It is represented by ϕ.

Electric flux for a small area

$$d\phi = \vec{E} \cdot \vec{ds}$$
$$d\phi = E\,ds\cos\theta \quad \text{--- (1)}$$

electric field (E), Small area (ds)

- Total flux —

$$\phi = \oint d\phi \quad \text{--- (2)}$$
$$\phi = \oint \vec{E} \cdot \vec{ds} \quad [\text{from eq}^n (1)]$$

unit $\rightarrow$ Nm^2C^{-1}

✡ Gauss law —

- Acc. to Gauss law electric flux passing through a electric is equal to the product of total charge Q and of $\frac{1}{\epsilon_0}$.

$$\phi = Q \times \frac{1}{\epsilon_0}$$

from eq^n (2)

$$\boxed{\phi = \frac{Q}{\epsilon_0} = \oint E \cdot ds}$$

from Coulomb's law →

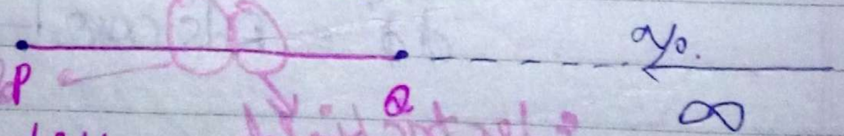
$$K = \frac{1}{4\pi\epsilon_0}$$

$$\epsilon_0 = \frac{1}{4\pi K}$$

✡ Electric potential, Electric energy, Electric Electric power —

Electric potential → Electric potential at a point in the electric field is the amount of work done in moving a +ve charge from ∞ to that point

$$V = \frac{W}{q_0}$$



Patential difference → Electric potential diff. betw. two point Q & P in an electric field is the amount of work done in moving +ve charge from Q to P.

$$V_P - V_Q = \frac{W}{q_0}$$

$$V = \frac{Kq}{r}$$

Electrical energy —

Electrical energy is denoted by U.

$$U = Vq$$

$$U = \frac{Kq_1 q_2}{r}$$

{we take q_1 & q_2 bec. two charges are present}

$$U = \frac{Kq_1 q_2}{r}$$

Total work done for a given time is Called electric energy.

$$\boxed{U = W = Vq}$$

✱ Electric Power —

- Electric power is denoted by P.
- Work done per unit time is called power.

$$P = \frac{W}{T} \quad \Big| \quad P = VI$$

$$P = IRI \rightarrow P = I^2R$$

- unit of power is watt or Joule/Sec

Or

$$P = V \times \frac{V}{R} \rightarrow P = \frac{V^2}{R}$$

✱ Capacitance & Capacitors —

- The ability of conductor to store charge in it is called Capacitance.

$$Q \propto V$$

$$C = \frac{Q}{V} \text{ or } Q = CV \quad \text{— (1)}$$

C → Capacitance of Conductor

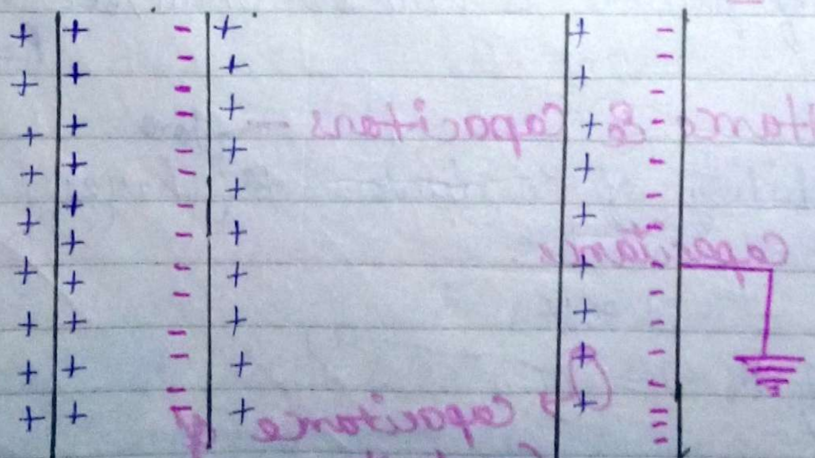
unit → Farad (F)

$1\ \mu F = 10^{-6} F$

$1\ pF = 10^{-12} F$

- Capacitors are the arrangement by which a large amount of charge can be stored in small place.

Let, us consider a plate A which is charged with some +ve charge
from eq^n — (1) it is clear that by decreasing the value of V capacity of conductor can be increased.
So, the value of potential can be decreased if another plate B is taken near to plate A, then negative charge is developed on plate B towards the plate A. and equal +ve charge is developed on the other side of plate B. which move into the ground when it is connected to earth.
So, potential reduces and capacity of conductor A increases



Capacitor and Condensor are same.

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There are various types of capacitors

→ Spherical Capacitor

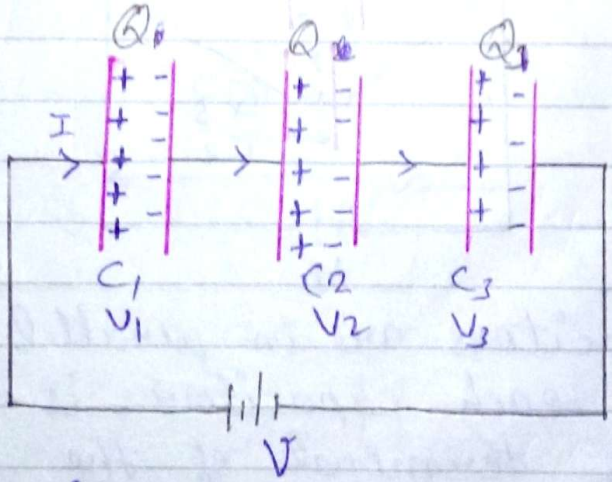
→ Parallel Capacitor

→ Cylindrical Capacitor

✡ COMBINATIONS OF CAPACITOR -

(1) Series combination
(2) Parallel Combination

(1) Series Combination :-



The capacitors are in series when IInd plate of first capacitor is ~~called~~ connected with the first plate of its following ~~characters~~ capacitors in a row.

$$Q = C_1V_1 \ , \ Q = C_2V_2 \ \text{and} \ Q = C_3V_3$$

$$V_1 = \frac{Q}{C_1} \ , \ V_2 = \frac{Q}{C_2} \ , \ V_3 = \frac{Q}{C_3}$$

Total potential → $V = V_1 + V_2 + V_3$

$$\frac{Q}{C} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$$

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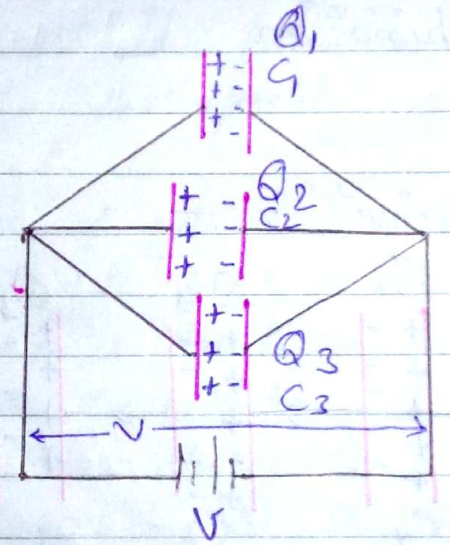
$$\frac{Q}{C} = Q\left[\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right]$$

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

So, in series combination ~~rep~~ reciprocal of total capacitance is equal to the sum of the reciprocals of individual capacitance connected in series.

(2) Parallel Combination —



The capacitors are in parallel when first plate of each capacitor is connected with the one terminal of the battery and the second plate is connected with the another terminal of the battery.

$$Q_1 = C_1 V, \quad Q_2 = C_2 V, \quad Q_3 = C_3 V$$

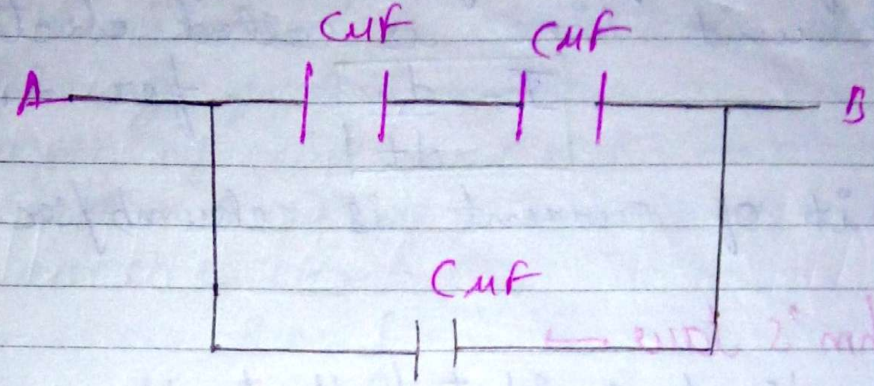
$$Q = Q_1 + Q_2 + Q_3$$

$$CV = C_1 V + C_2 V + C_3 V$$

$$C\cancel{V} = \cancel{V}C(C_1 + C_2 + C_3)$$

$$C_{Se} = C_1 + C_2 + C_3$$

So, in parallel combination total capacitance is equal to the sum of individual capacitances connected in the circuit.



Ques → Find equivalent capacitor?

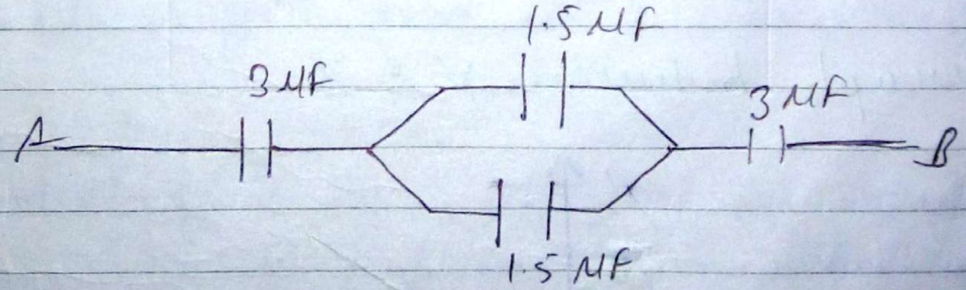
$$\rightarrow \frac{1}{C_s} = \frac{1}{C} + \frac{1}{C}$$

$$C_s = \frac{C}{2}\ \mu f$$

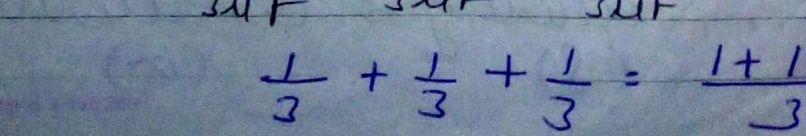
Then, $C_{eq.} = \frac{C}{2} + C$

$$\boxed{C_{eq} = \frac{3C}{2}\ \mu f}$$

Ques →



$$c = C_1 + C_2$$
$$c = 1.5 + 1.5$$
$$c = 3\ \mu f$$



$$\frac{1}{3} + \frac{1}{3} + \frac{1}{3} = \frac{1+1+1}{3} = 1\ \mu f$$

✯ Electric current →

The electric current is define as the rate of flow of charges through a Conductor per unit time is called electric current.

$$\boxed{I = \frac{dq}{dt}} \longrightarrow \text{for Small part}$$

unit of current is coloumb/sec or Ampere (A)

✯ Ohm's law →

Ohm's law Stated that the potential difference of the conductor is directly proportional to the current flowing through the conductor.

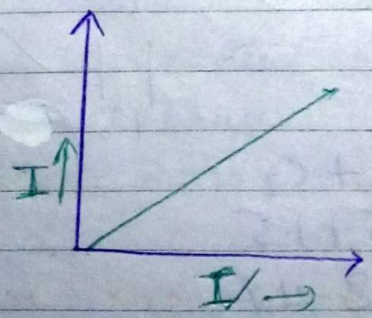
$$V \propto I$$

$$V = RI \quad \text{or} \quad V = IR$$

$$R = \frac{V}{I}$$

R is a constant called resistor
unit of R is Volt/A or Ω (Ohm).

Graph between V & I.



✯ Resistance, Resistivity & Conductivity —
(R) (ρ) (σ)

- Obstruction produce by the conductor to the flow of charges (flow of current) is called resistance of the conductor.
- The resistance of conductor depends upon following factors —

(1) length of wire → $R \propto l$. —— (i)

(1A) (2) Crossection area of wire → $R \propto 1/A$ —— (ii)

from (i) & (ii)

$$R \propto \frac{l}{A}$$

$$R = \rho \frac{l}{A}$$

ρ is a constant is called Resistivity or Specific resistance

$$\rho = \frac{RA}{l}$$

→ unit of ρ → $\frac{Ohm\ m^2}{m}$ ⇒ Ohm m

- Thus, electrical resistivity of the material is equal to the resistance of wire of unit length and unit cross-section area

✡ Conductivity → (σ)

Conductivity is the reciprocal of resistivity

$$\sigma = \frac{1}{\rho} = \frac{1}{Ohm\text{-}m} = Ohm^{-1} m^{-1} \text{ or } mho\, m^{-1}$$

✡ Electromotive force and Terminal potential difference —

Electromotive force →
Electromotive force of a cell is the maximum potential difference between the cells when it is in the open circuit. i.e. when no current is drawn from the cell

Terminal potential difference →
The potential difference between the cell in a closed circuit i.e. when current is drawn from the cell is called terminal potential difference

$$E = V + Ir \qquad (E > V)$$

Series and Parallel Combination of Resistance -

(1) Series Combination :-

In diagram three Resistances R_1, R_2 and R_3 are connected in Series. V_1, V_2, V_3 are the potential difference across R_1, R_2, R_3, Respectively
Acc. to Ohm's law -

$$V = IR$$

$$V_1 = IR_1$$

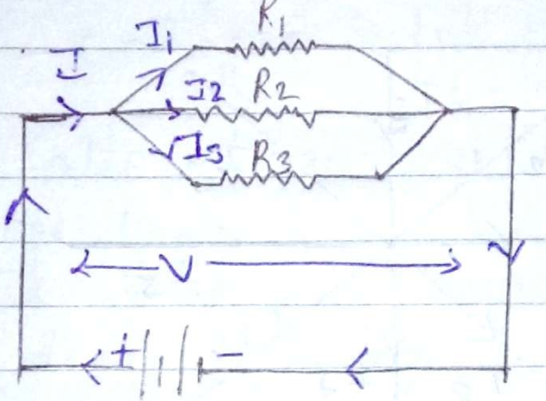
$$V_2 = IR_2$$

$$V_3 = IR_3$$

$$V = V_1 + V_2 + V_3$$
$$IR = IR_1 + IR_2 + IR_3$$
$$\cancel{I} R = \cancel{I} (R_1 + R_2 + R_3)$$
$$R_s = R_1 + R_2 + R_3$$

Resistance in series is equal to the sum of the individual resistance.

(2) Resistance in parallel –



$$V = IR \rightarrow I = V/R$$

Resistance of $V = I_1 R_1 \longrightarrow I_1 = V/R_1$

Resistance of $= I_2 R_2 \longrightarrow I_2 = V/R_2$

Resistance of $= I_3 R_3 \longrightarrow I_3 = V/R_3$

$$I = I_1 + I_2 + I_3$$
$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$
$$\frac{\cancel{V}}{R} = \cancel{V}\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$$
$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

If n resistance are connected in parallel,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \cdots\cdots + \frac{1}{R_n}$$

Kirchoff's law →

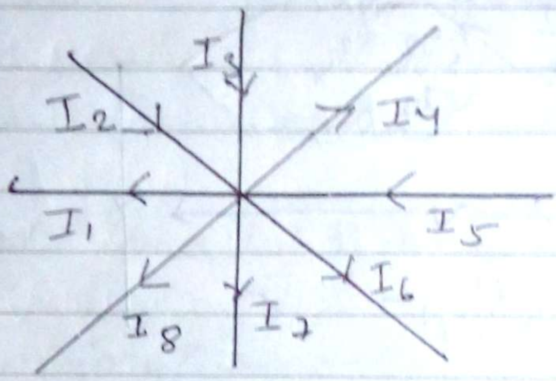
(1) First law →

In an electric circuit, the algebric sum of currents at any junction is zero.

OR.

The sum of currents entering a junction is equal to the sum of currents leaving that junction.

$$\Sigma I = 0$$



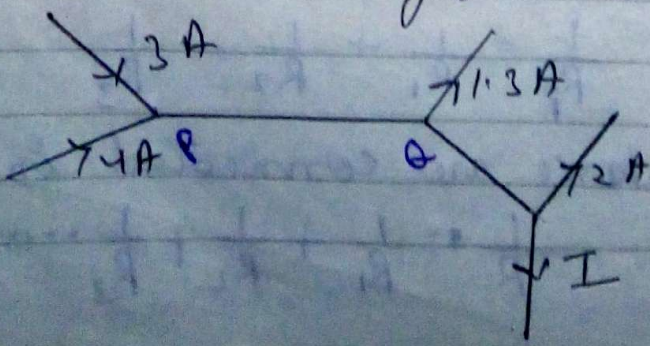
$$-I_1 + I_2 + I_3 - I_4 + I_5 - I_6 - I_7 - I_8$$

$$\rightarrow \quad I_2 + I_3 + I_5 = I_1 + I_6 + I_7 + I_8$$

- Sign Convention →

(i) The current flowing in a circuit towards the junction is taken as positive and current flowing away from the junction is taken as negative.

Ques→ In The following diagram find the value of current I in given branch?



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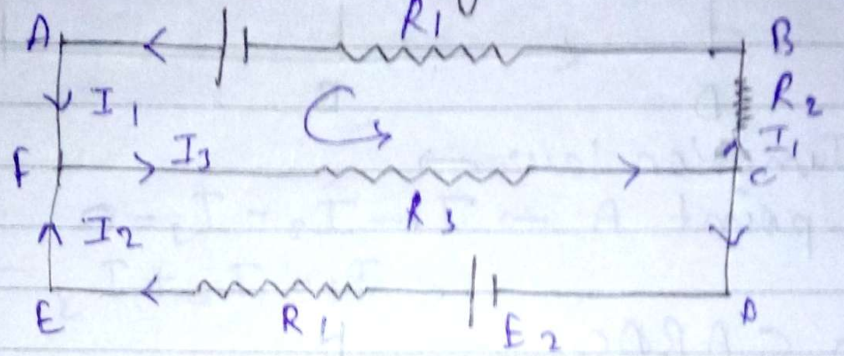
Sol^n →
$$I = 3 + 4 - 1.3 - 2$$
$$I = 7 - 3.3$$
$$I \Rightarrow 3.7\ A$$

(2) Second law → or Voltage law or loop law →



This is also known as Kirchoff's loop law and voltage law.
It states that in any close path of an circuit, the algebric sum of voltage is equal to the sum of E.M.F. in that loop.

$$\Sigma E = \Sigma V$$
$$\Sigma E = \Sigma IR$$

(A) If the direction of current is along the path then E.M.F. of cell is taken +ve otherwise -ve.
(B) The voltage drop on resistance is taken positive if one moves in the direction of current and is taken -ve if one move in the opp. dir^n of current.

Closed loop AFCBA
$$I_3R_3 + I_1R_2 + I_1R_1 = E_1 \quad \text{—— (1)}$$
Closed loop AEDBA
$$-I_2R_4 + I_1R_2 + I_1R_1 = E_1 - E_2 \quad \text{—— (2)}$$

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Parallel plate Capacitor →

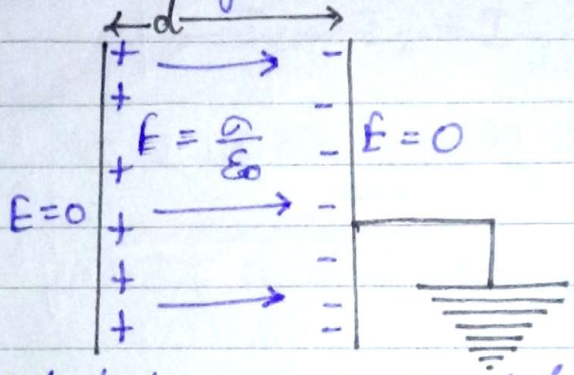
The simplest and the ~~#~~ most widely used capacitor is the parallel plate capacitor. It consists of two large plane parallel conducting plates, seperated by a small distance.

A = Area of each plate

d = Distance between the two plates

$\pm\sigma$ = uniform charge densities on the two plates

$\pm Q$ = Total charge on each plate.



Electric field between two plates. $E = \frac{\sigma}{\varepsilon_0}$ —(1)

Sigma is surface charge densities. $\sigma = \frac{Q}{A}$ —(2)

from eq^n (1) & (2)

$$E = \frac{Q}{\varepsilon_0 A} \quad \text{—(3)}$$

potential difference between these plates is

$$V = E\,d$$

$$V = \frac{Q\,d}{\varepsilon_0 A} \quad \text{— [from eq}^n\text{ (3)]}$$

capacity. $C = \frac{Q}{V} \rightarrow C = \frac{Q}{\frac{Q\,d}{\varepsilon_0 A}}$

$$C = \frac{\cancel{Q} \times \varepsilon_0 A}{\cancel{Q}\,d} \rightarrow \boxed{C = \frac{\varepsilon_0 A}{d} \text{ Farad}}$$

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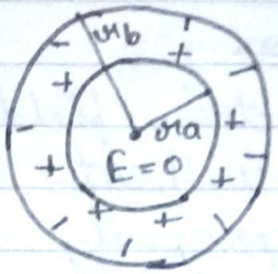
Spherical plate capacitor →

A Spherical capacitor consist of two concentric ~~Spheric~~ Spherical ~~shells~~ shells of timer
inner and outer raddi r_a and r_b.
The two shells carry charges $+Q$ and $-Q$ respectively.
Inside a ~~e~~ hollow conductor E is 0.
Outside the outer shell electric field is also 0.



$$V = \frac{KQ}{R}$$

$$V = V_A - V_B$$

$$V = \left[\frac{KQ}{r_a} - \frac{KQ}{r_b}\right]$$

$$V = KQ\left[\frac{1}{r_a} - \frac{1}{r_b}\right]$$

$$V = KQ\left[\frac{r_b - r_a}{r_a r_b}\right]$$

$$C = \frac{Q}{V}$$

$$C = \frac{\cancel{Q}}{K\cancel{Q}\left[\frac{r_b - r_a}{r_a r_b}\right]}$$

$$C = \frac{r_a r_b}{K(r_b - r_a)} \rightarrow C = \frac{r_a r_b}{\frac{1}{4\pi\epsilon_0}(r_b - r_a)}$$

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$$C = 4\pi\epsilon_0 \cdot \frac{r_a r_b}{r_b - r_a}$$

Dielectric →

- A dielectric substance is a substance which does not allow the flow of charges through it but permits them to exert electrostatics forces on one another through it.
- A dielectric is essintially an insulator which can be polarised through small localised displacements of its charges.

Dielectric Strength →

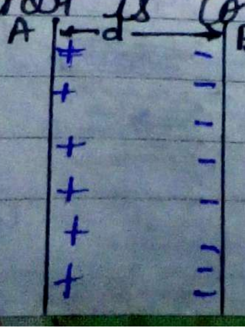
The maximum electric field that can exist in a dielectric slab without causing the breakdown of its insulating property is called dielectric strength of the material.

Capacitors with dielectric →

- When capacitor is completely filled with dielectric
- When capacitor is partially with dielectrics
- When capacitor is completely filled with two or more dielectric

(i) when capacitor is completely with dielectric —

-



Capacity of parallel plate capacitor is —

$$C_0 = \frac{\epsilon_0 A}{d} \quad \text{—(1)}$$

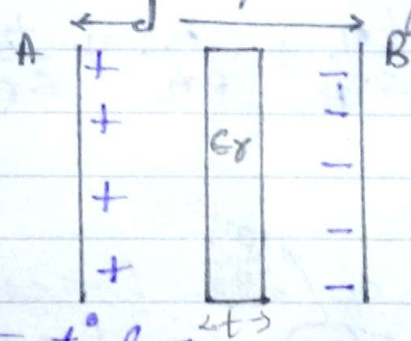
$$C_m = \frac{\epsilon_0 \epsilon_r A}{d} \quad \text{—(2)} \quad [\epsilon_m = \epsilon_0 \epsilon_r]$$

$$C_m = C_0 \epsilon_r$$

from eq^n (1) & (2)

$$\frac{C_0}{C_m} = \frac{\frac{\cancel{\epsilon_0} \cancel{A}}{\cancel{d}}}{\frac{\cancel{\epsilon_0} \epsilon_r \cancel{A}}{\cancel{d}}} \Rightarrow \epsilon_r$$

(ii) When capacitor is partially filled with dielectric —



potential —

$$V = E_0 (d-t) + E_m t$$

$$V = \frac{Q}{\epsilon_0 A}(d-t) + \frac{Qt}{\epsilon_0 \epsilon_r A}$$

$$V = \frac{Q}{\epsilon_0 A}\left[d - t + \frac{t}{\epsilon_r}\right]$$

$$C = \frac{Q}{V}$$

$$C = \frac{\cancel{Q}}{\frac{\cancel{Q}}{\epsilon_0 A}\left[d-t+\frac{t}{\epsilon_r}\right]} \rightarrow \boxed{C = \frac{\epsilon_0 A}{d - t + \frac{t}{\epsilon_r}}}$$

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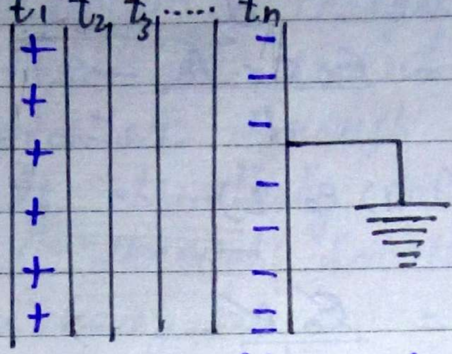
(iii) When capacitors is filled with two or more dielectrics



Let, the capacitor is filled with the dielectric constant $\epsilon_{r1}, \epsilon_{r2}, \epsilon_{r3}, \ldots \epsilon_{rn}$ with thickness $t_1, t_2, t_3 \ldots t_n$ respectively

$$C_m = \frac{\epsilon_0 A}{\left(\frac{t_1}{\epsilon_{r1}} + \frac{t_2}{\epsilon_{r2}} + \frac{t_3}{\epsilon_{r3}} \cdots \frac{t_n}{\epsilon_{rn}}\right)} \text{ farad}$$

Ques → find the ratio of the forces when two charges of 1.5 mc (10^{-3}) and 0.2 mc are placed at a distance of 1 m in free space two inner medium having permitivi-ty $2\epsilon_0$?

Solution → Given $\begin{cases} q_1 = 1.5\,mC = 1.5 \times 10^{-3}\,C, & r = 1\,m \\ q_2 = 0.2\,mC = 0.2 \times 10^{-3}\,C \end{cases}$

$$F = \frac{K q_1 q_2}{r^2}, \quad F_m = \frac{K q_1 q_2}{r^2}$$

$$F_0 = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}, \quad F_m = \frac{1}{4\pi 2\epsilon_0} \frac{q_1 q_2}{r^2}$$

$$\frac{F_0}{F_m} = \frac{\frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}}{\frac{1}{4\pi 2\epsilon_0} \frac{q_1 q_2}{r^2}}$$

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$$\frac{F_o}{F_m} = \frac{2\epsilon\sigma}{\epsilon\sigma} \rightarrow 2:1$$

Ratio of the forces is 2:1

Ques If the area of parallel plate capacitor is doubled and the distance between plates is half then what will be the effect of capacitance?

Ans- formula = $C = \frac{\epsilon_0 A}{d}$

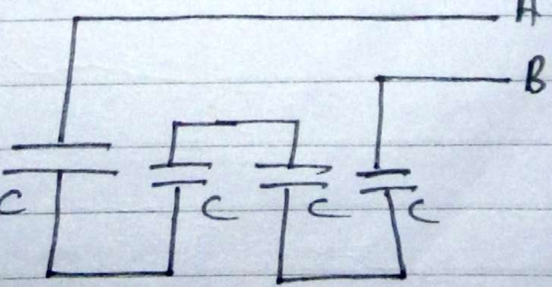
Given $\begin{cases} A = 2A \\ d = d/2 \end{cases}$

$\Rightarrow C_1 = \frac{\epsilon_0 A \times 2 \times 2}{d}$

$\Rightarrow C_1 = \frac{4\epsilon_0 A}{d}$

$\Rightarrow C_1 = 4C$

Ques → find equivalent capacitance between A & B?



Solution →

$$\frac{1}{C_s} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C} + \frac{1}{C}$$

$$\frac{1}{C_s} = \frac{4}{C}$$

$$C_s = \frac{C}{4}$$